Cβ: Cornell-BNL ERL-FFAG Test Accelerator

Optics considerations

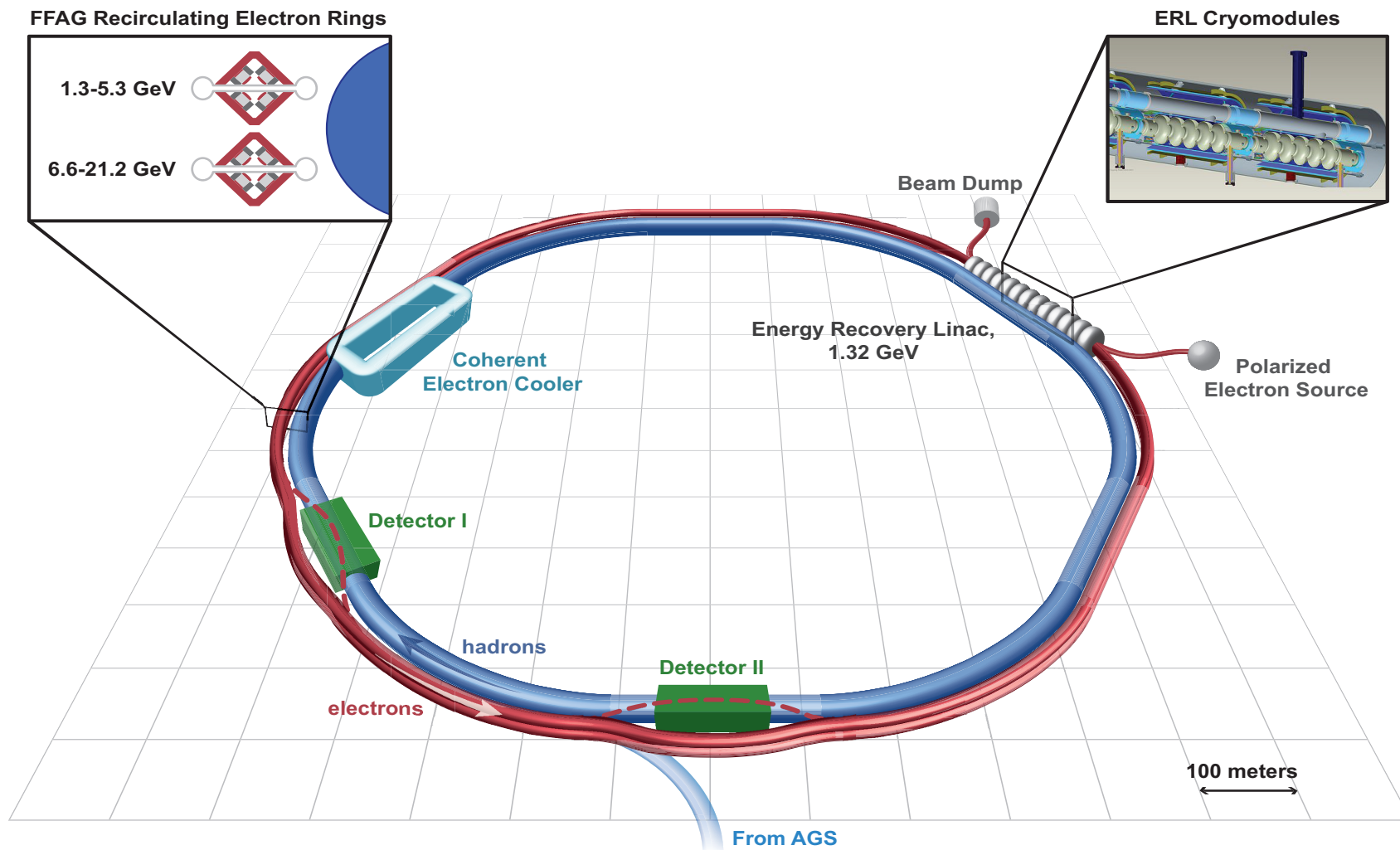Christopher Mayes – June 10, 2015

Cβ: Cornell-BNL ERL-FFAG Test Accelerator

6 MeV

6 MeV

+/- 70 MeV

76, 146, 214, 286 MeV

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eRHIC

FFAG Recirculating Electron Rings

1.3-5.3 GeV

6.6-21.2 GeV

ERL Cryomodules

Beam Dump

Energy Recovery Linac, 1.32 GeV

Polarized Electron Source

Coherent Electron Cooler

Detector I

hadrons

Detector II

electrons

100 meters

From AGS
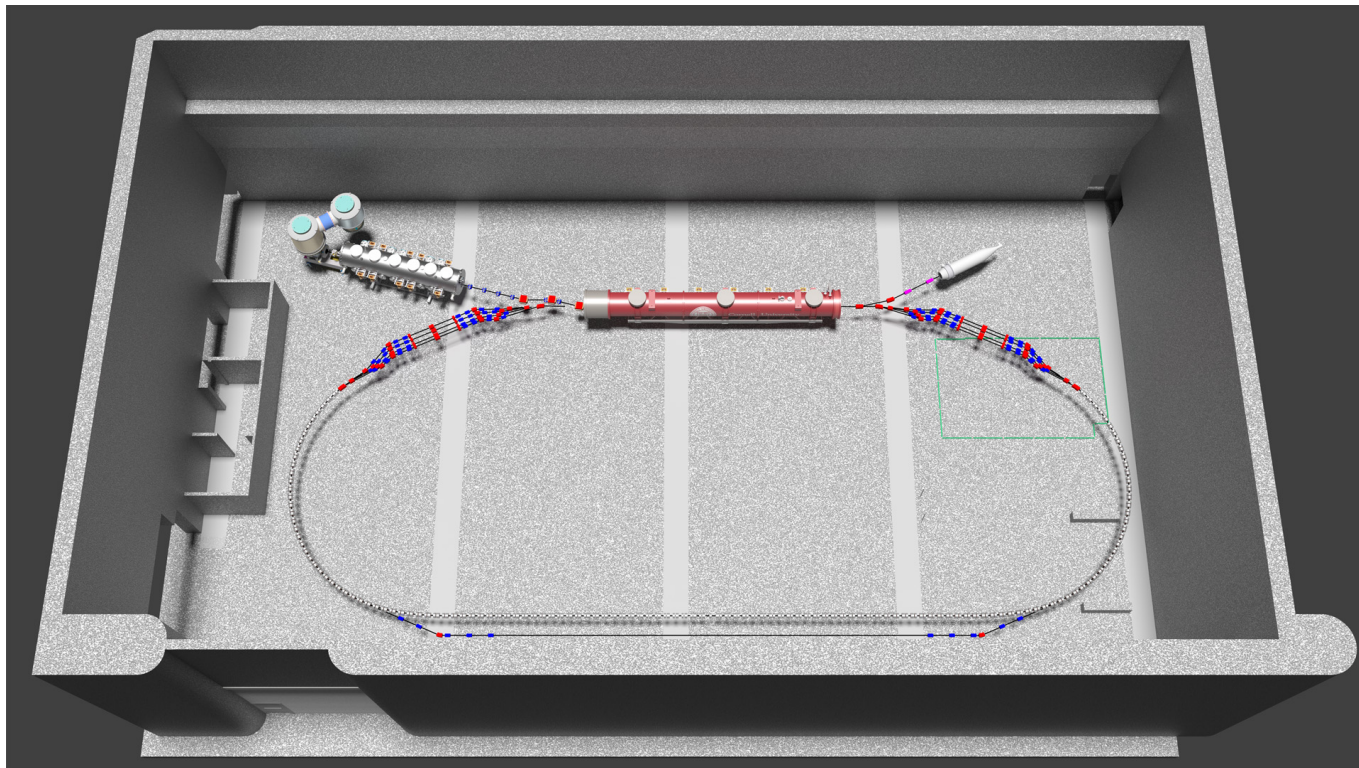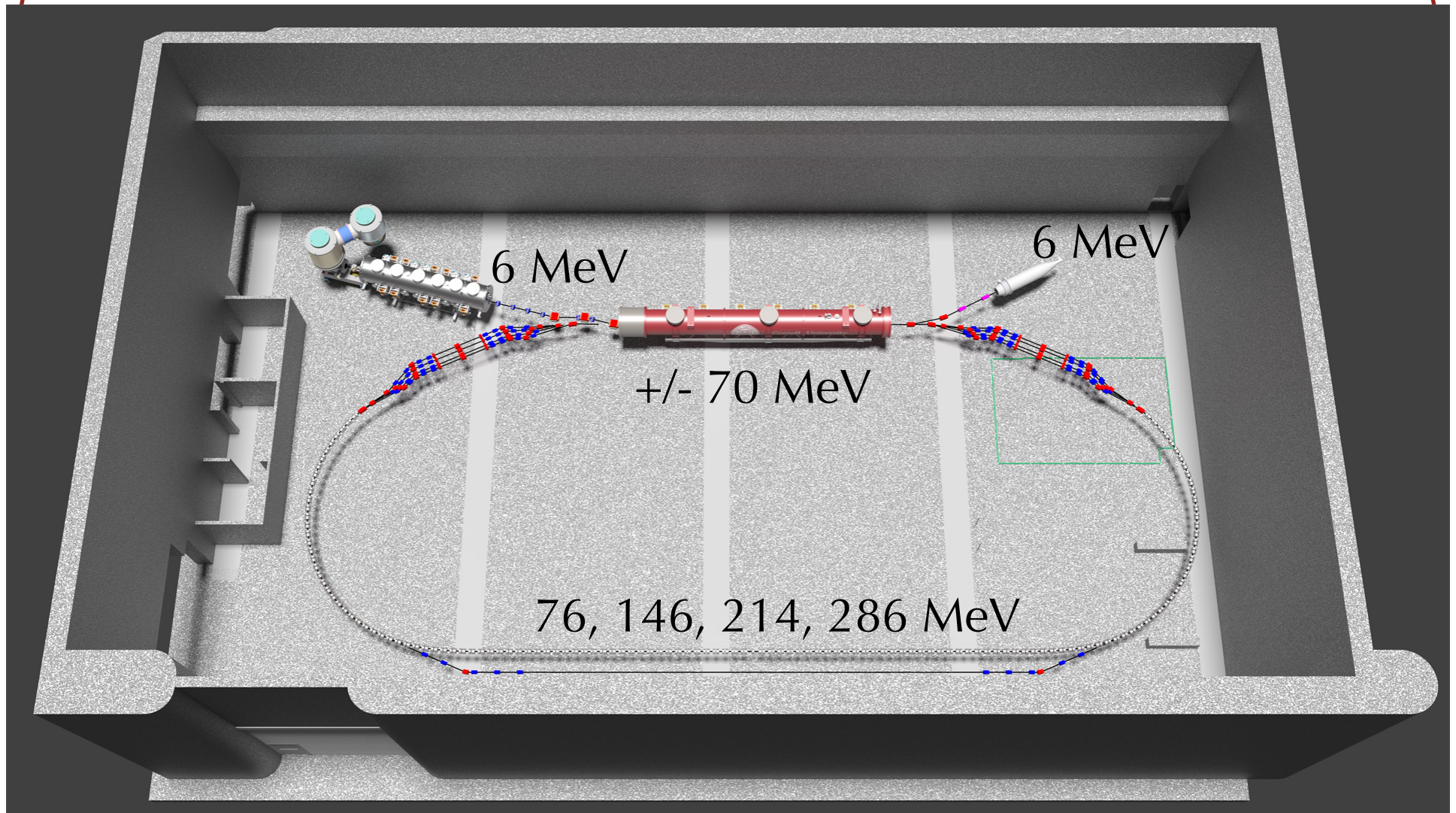
arxiv.org/abs/1409.1633

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Cβ White Paper

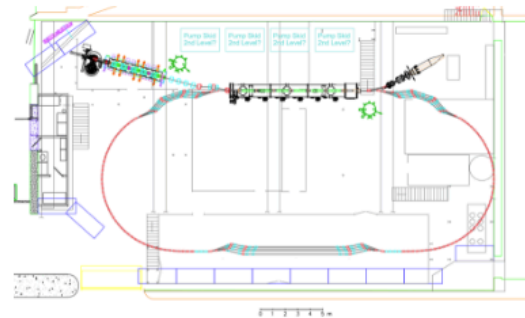**The Cornell-BNL FFAG-ERL Test Accelerator**

White Paper

Ivan Bazarov, John Dobbins, Bruce Dunham, Georg Hoffstaetter,
Christopher Mayes, Ritchie Patterson, David Sagan

Cornell University, Ithaca NY

Ilan Ben-Zvi, Scott Berg, Michael Blaskiewicz, Stephen Brooks,
Kevin Brown, Wolfram Fischer, Yue Hao, Wuzheng Meng,
François Méot, Michiko Minty, Stephen Peggs, Vadim Ptitsin,
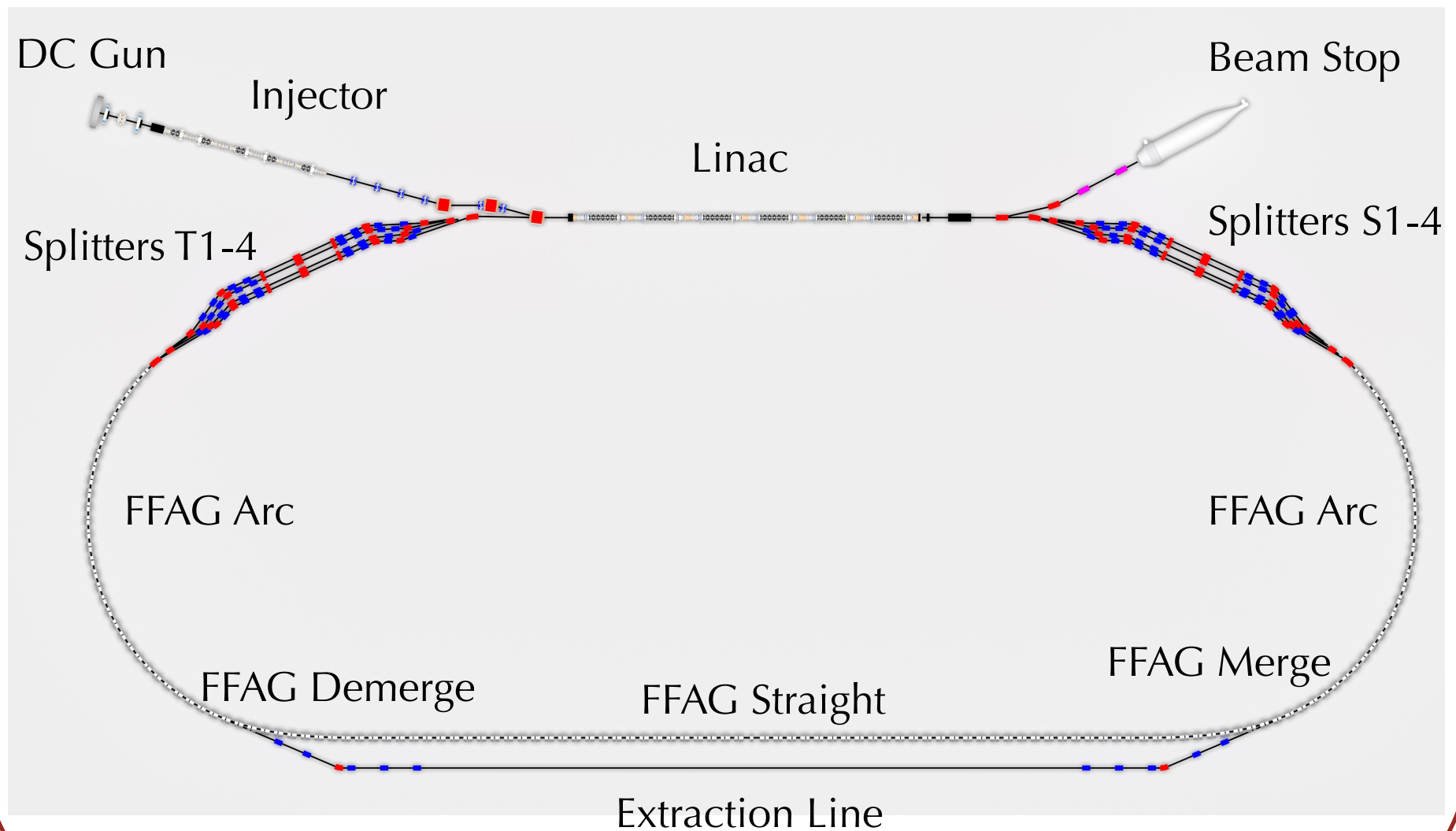Thomas Roser, Peter Thieberger, Dejan Trbojevic, Nick Tsoupas.

Brookhaven National Laboratory, Upton NY

December 16, 2014

arXiv:1504.00588v1 [physics.acc-ph] 2 Apr 2015

arxiv.org/abs/1504.00588

Layout

DC Gun

Injector

Beam Stop

Linac

Splitters S1-4

Splitters T1-4

FFAG Arc

FFAG Arc

FFAG Demerge

FFAG Straight

FFAG Merge

Extraction Line

FFAG Optics

Cell

Merge (10 cells)

286 MeV

216 MeV

76 MeV

146 MeV

3.6 deg

8 cm   11 cm
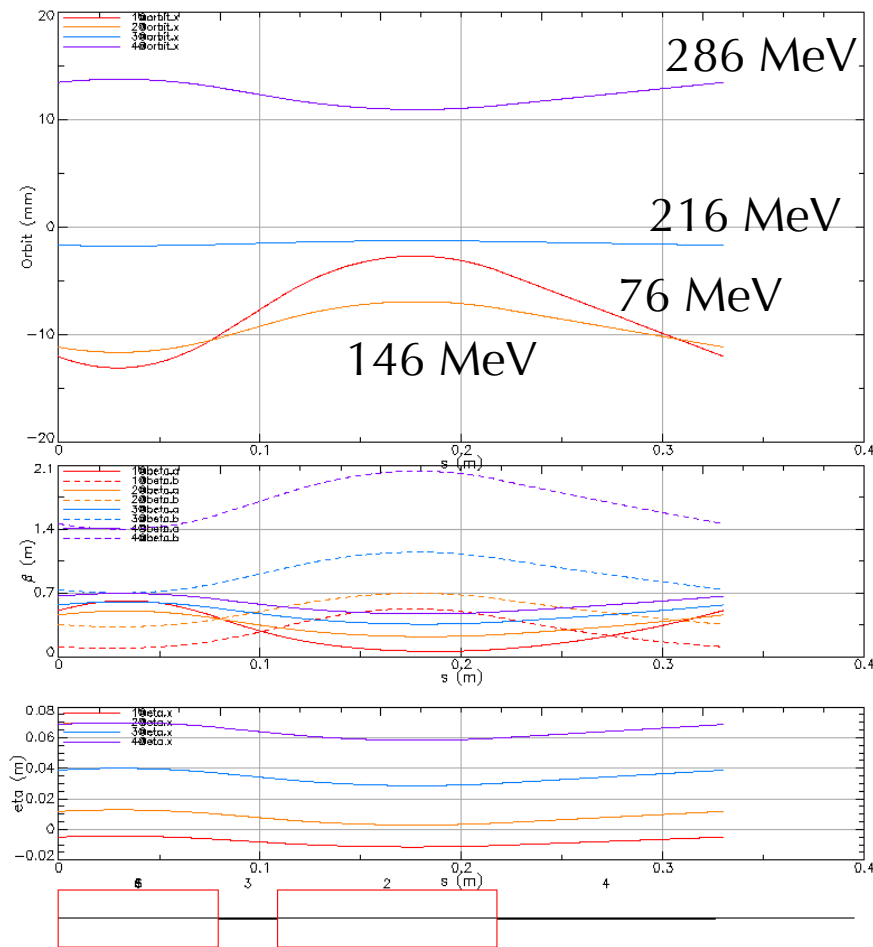
42.5 T/m   -27.5 T/m

-0.104 T   0.5044 T
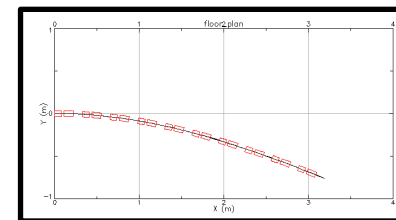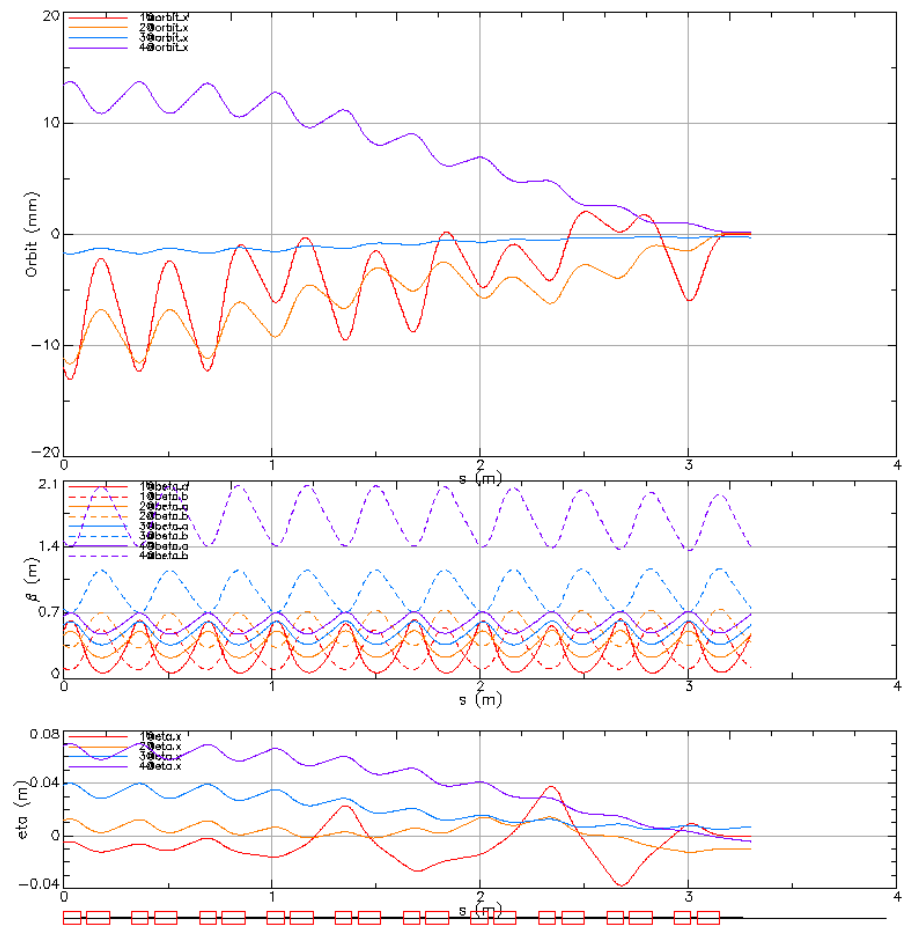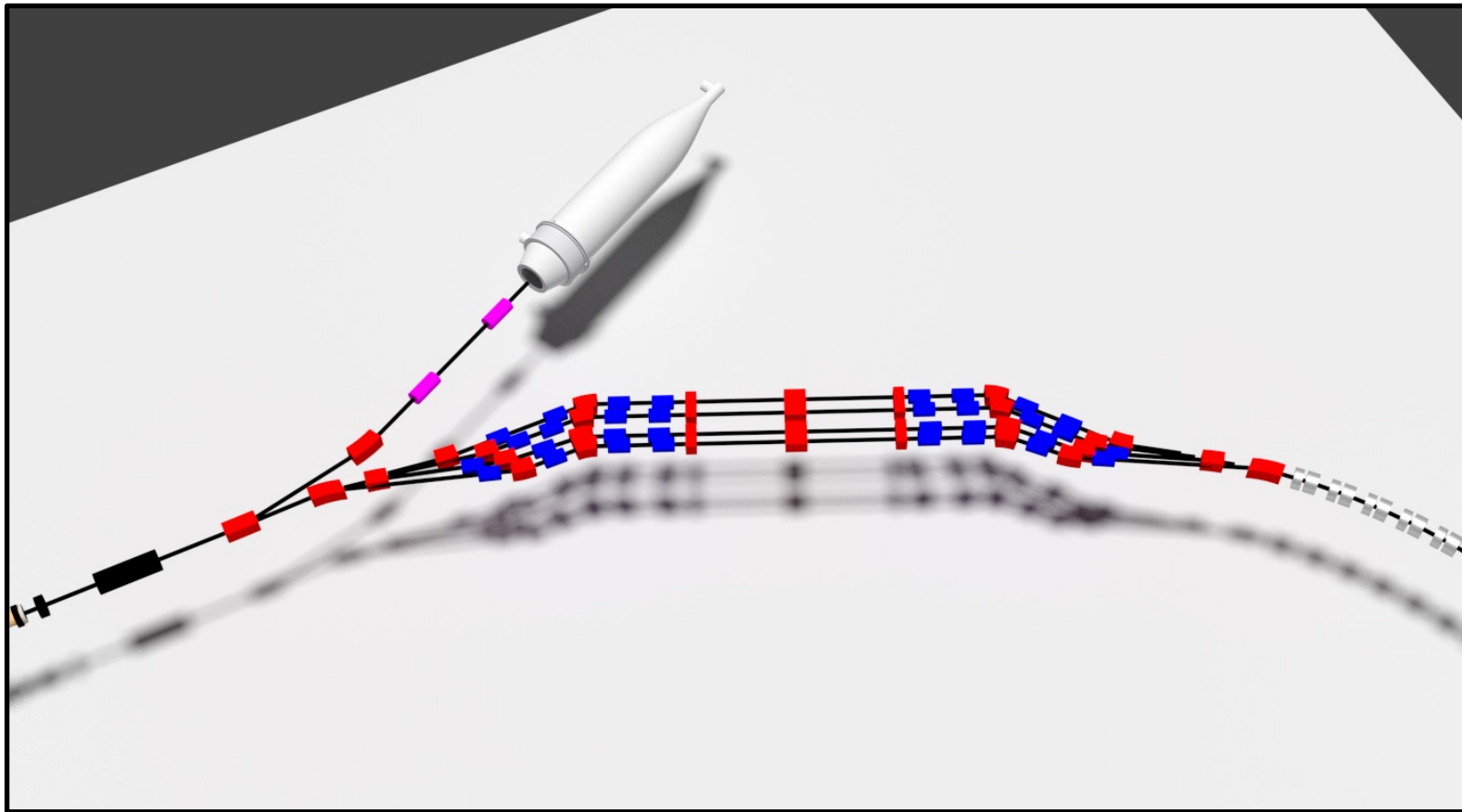
22 deg

FFAG Arc, Merge, Straight

extract

286 MeV

76, 146, 216 MeV
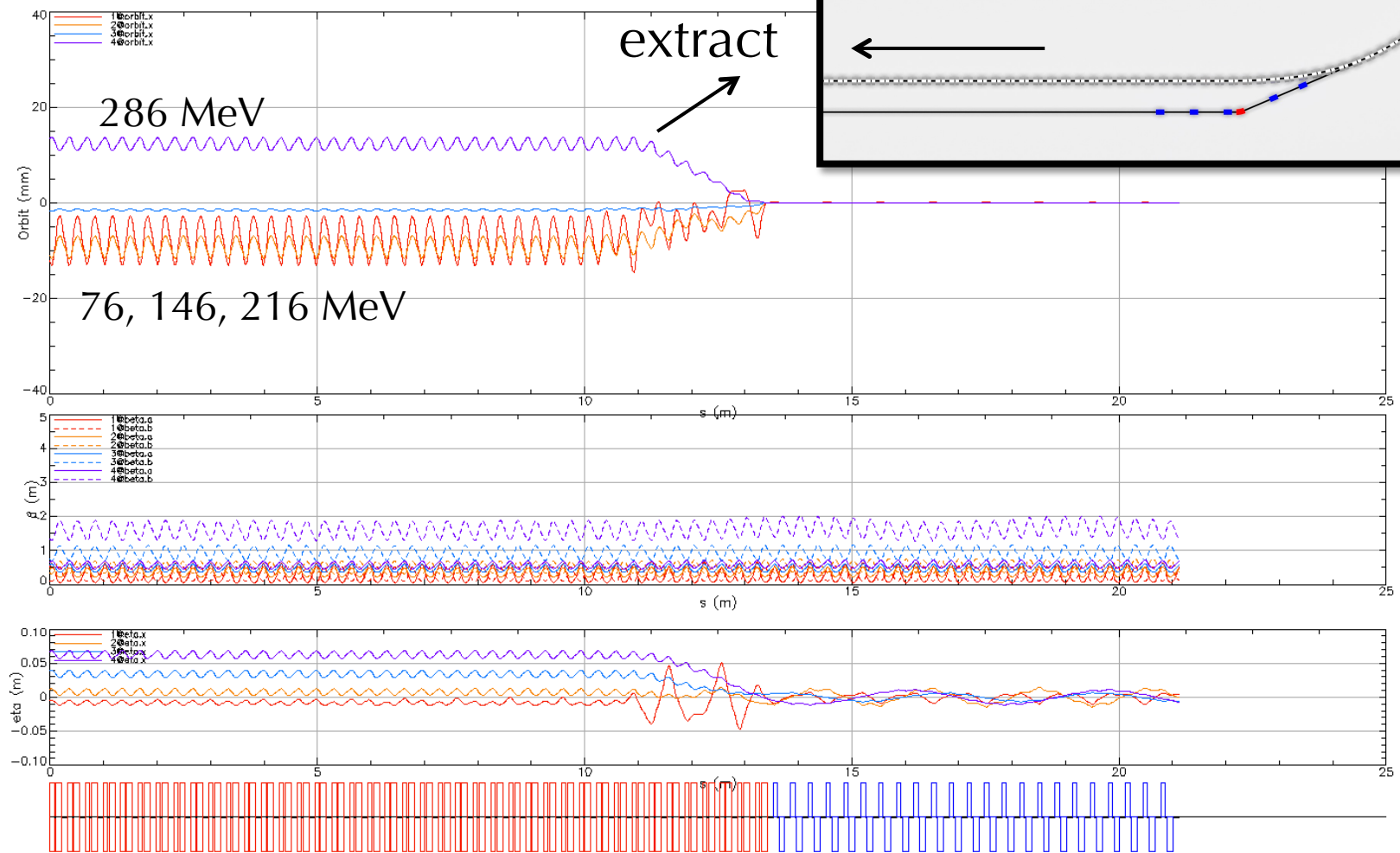
Splitters S1-4

- Accept large beams from Linac
- Steer onto FFAG closed orbits
- Match to FFAG optics
- r_{56} adjustment
- Path length adjustment via vertical chicanes
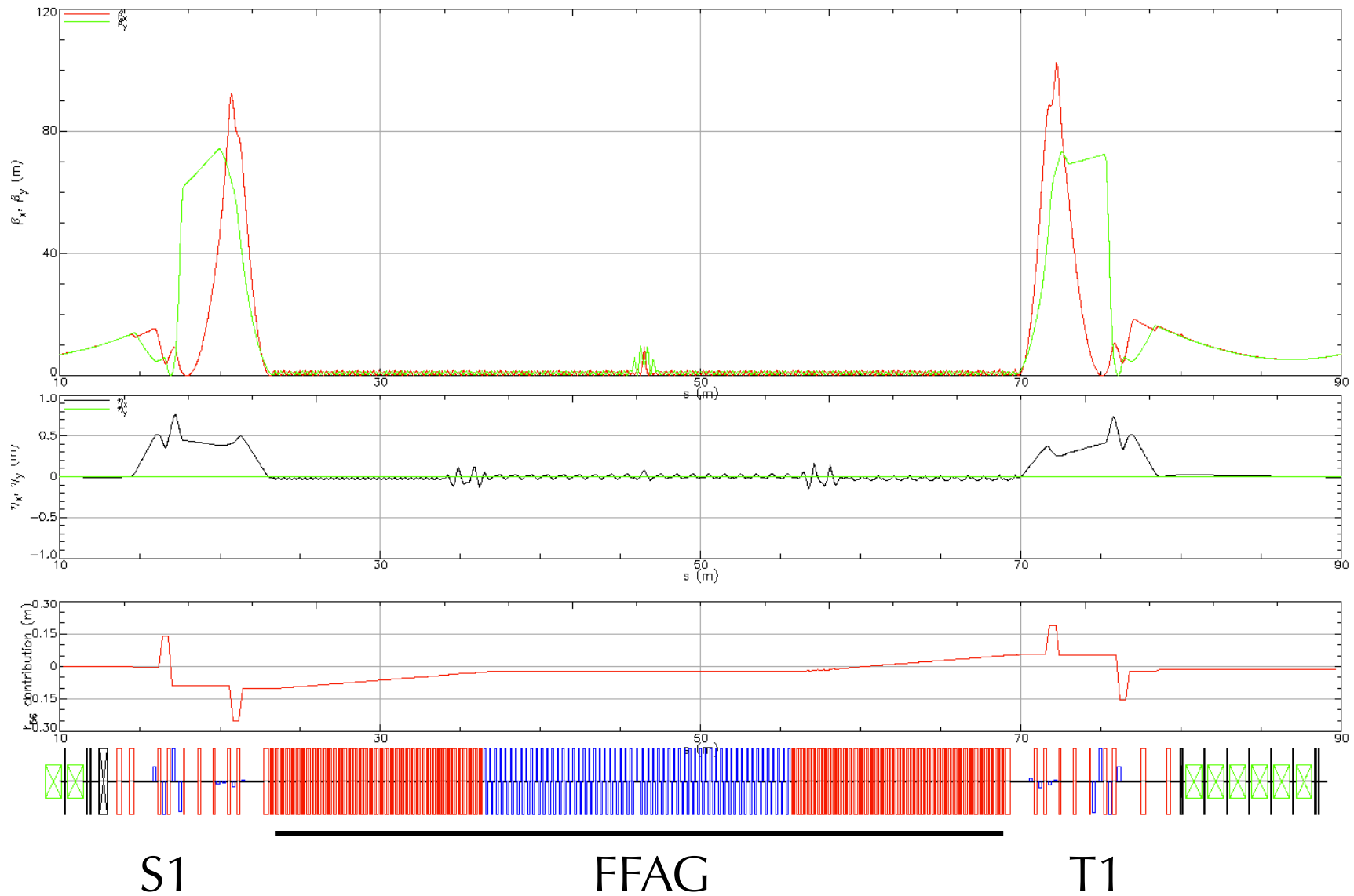- Total path lengths close to ideal for ERL operation

Splitter S1
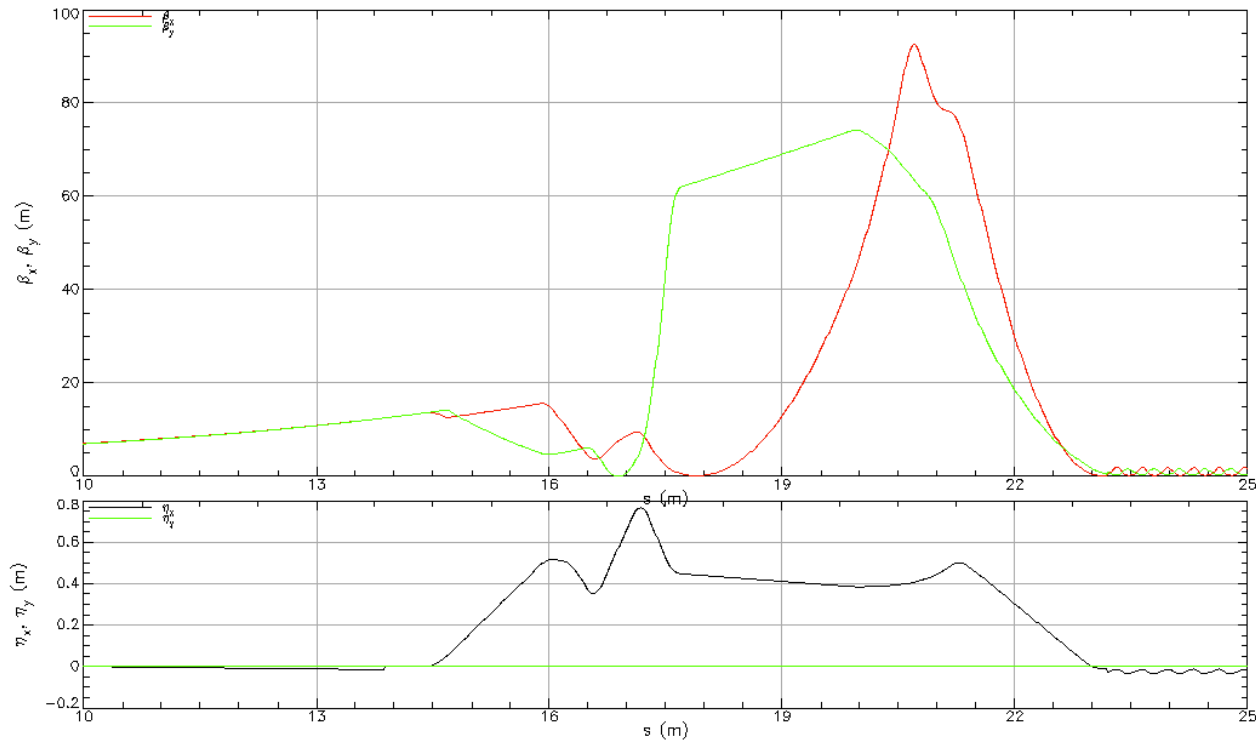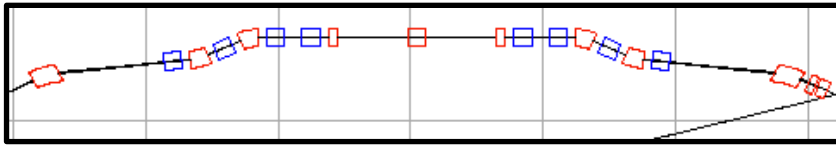
r_{56}
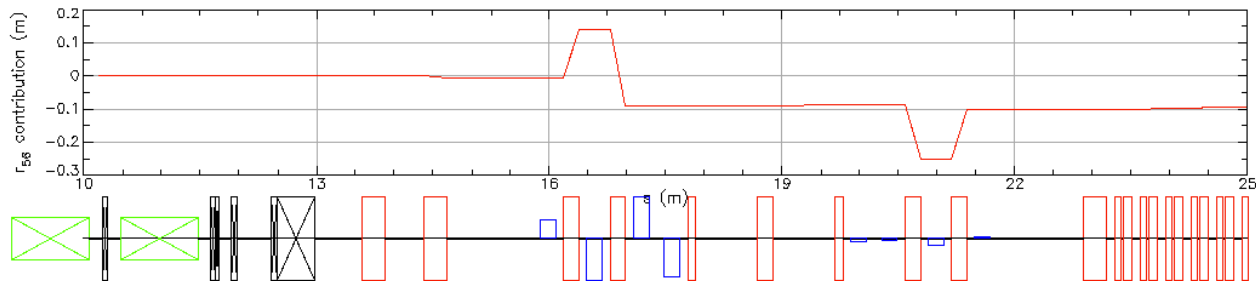
Linac

Vertical
chicane

FFAG

Pass 1 optics

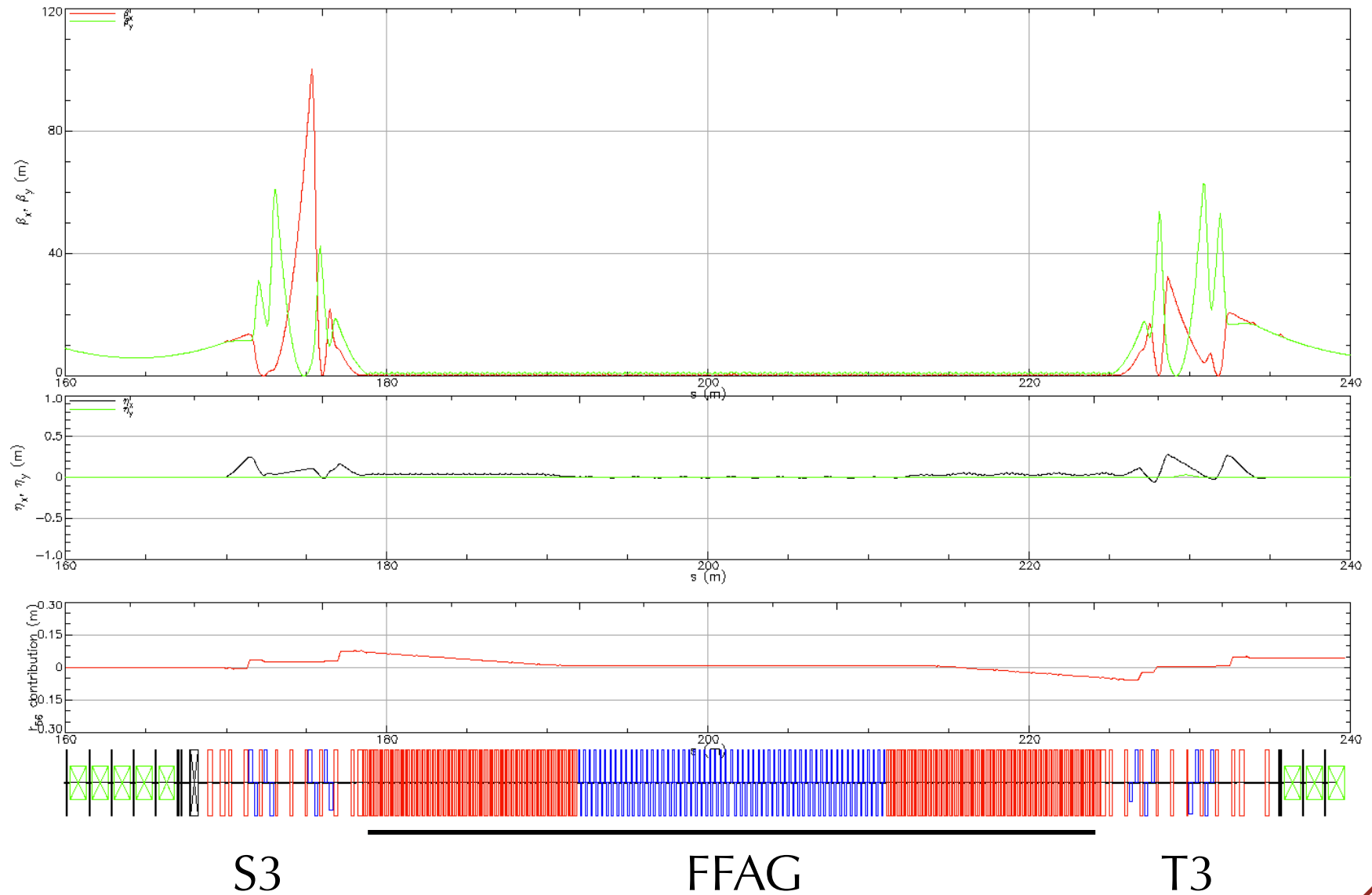76 MeV

to 146 MeV

S1

FFAG

T1

Pass 2 optics

146 MeV   to 216 MeV
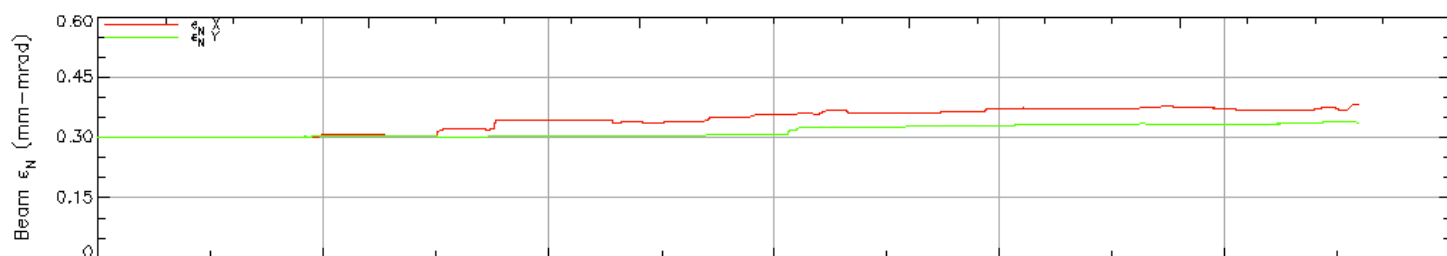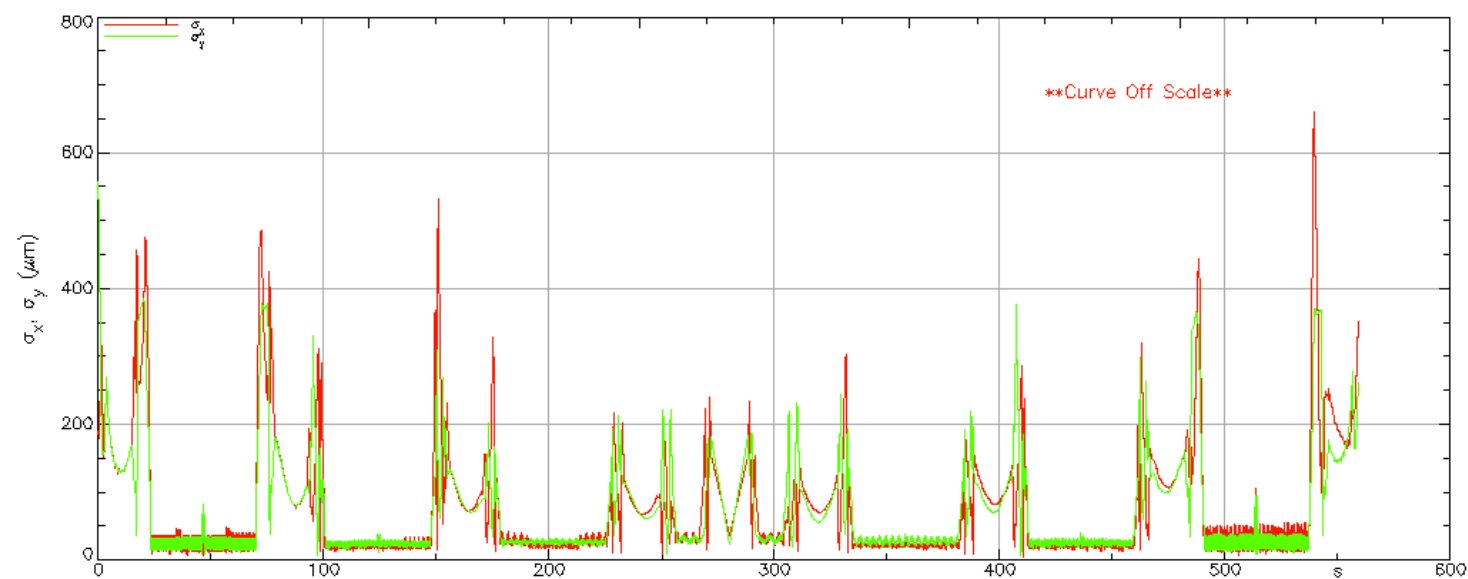

S2   FFAG   T2

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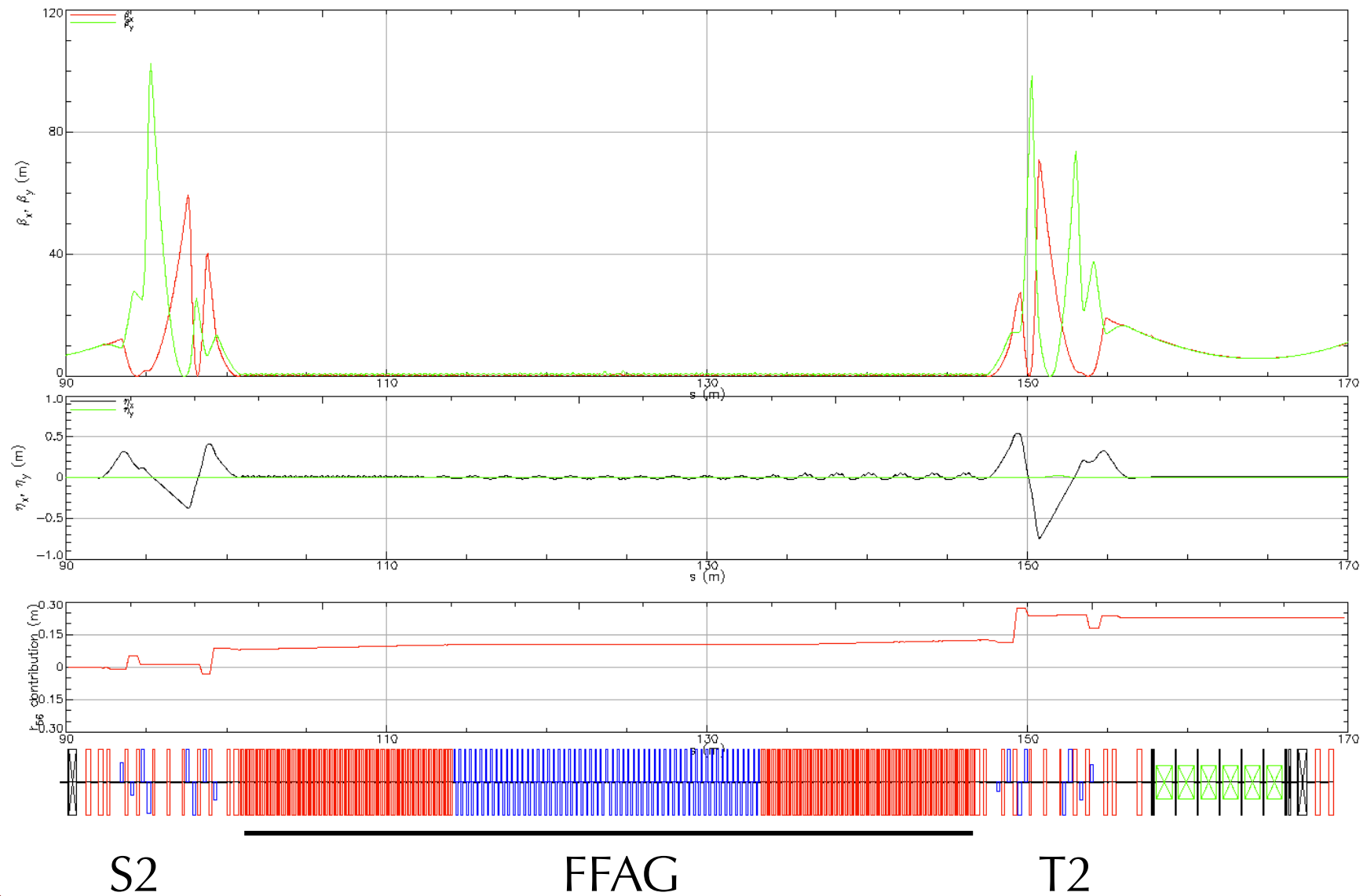
Pass 3 optics

216 MeV   to 286 MeV

S3   FFAG   T3

Pass 4 optics

286 MeV

Decelerate
to 216 MeV
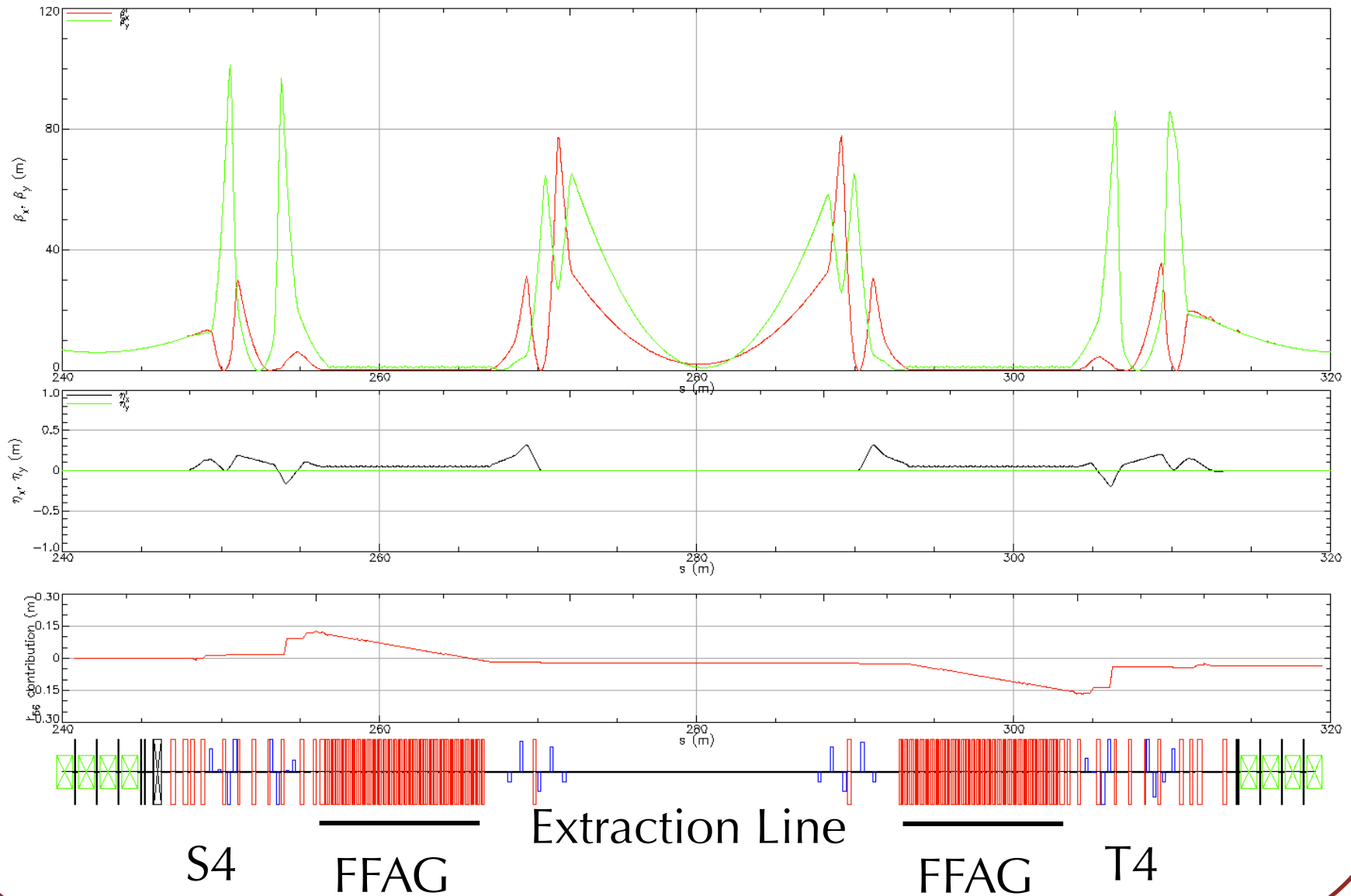
S4   FFAG   Extraction Line   FFAG   T4

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Full ERL bunch tracking

286 MeV

6 MeV   6 MeV

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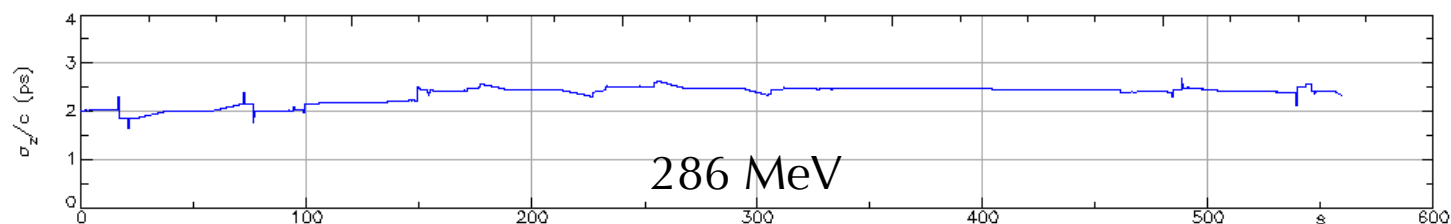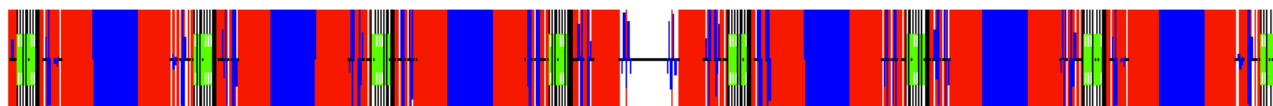
Longitudinal Phase Space

end of the Linac for pass (full scale 8%)
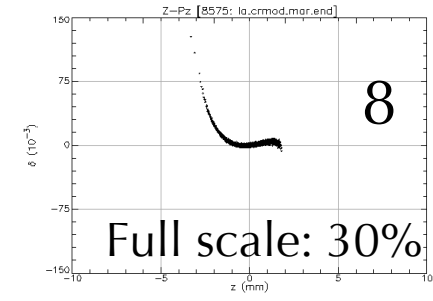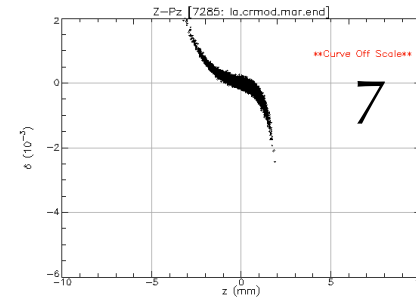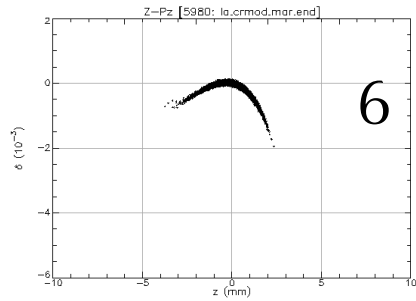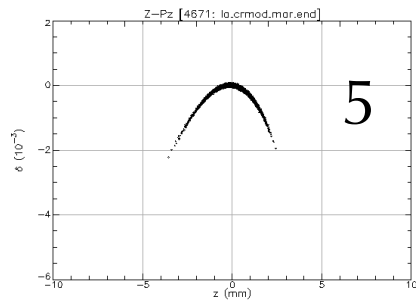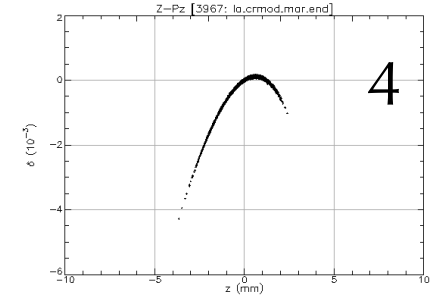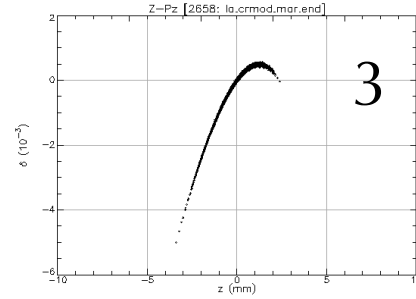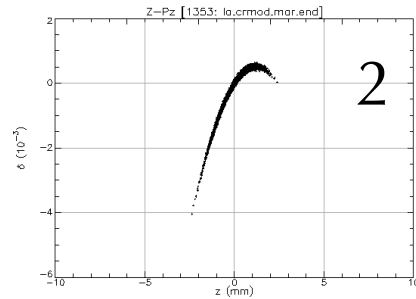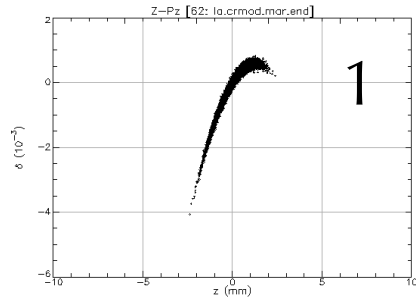
Longitudinal Phase Space

end of the Linac for pass (full scale 8%)

r_{56} adjusted on pass 4
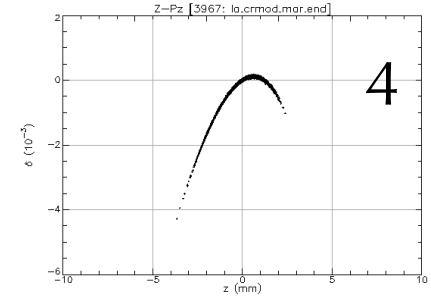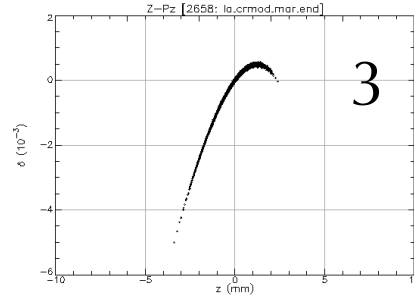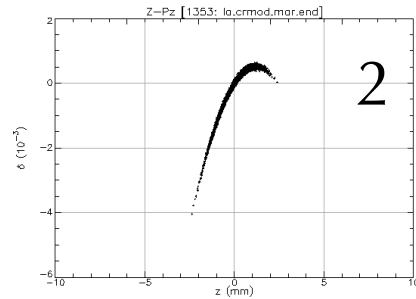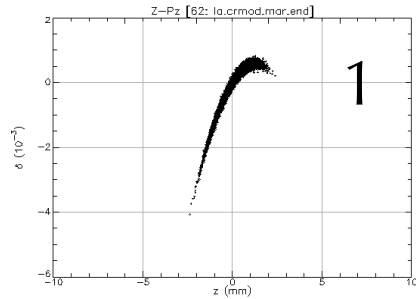
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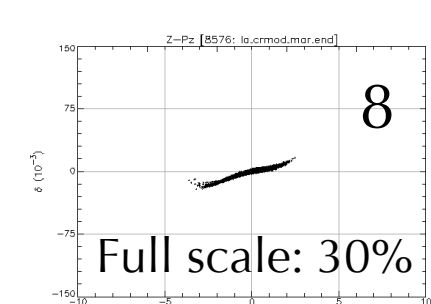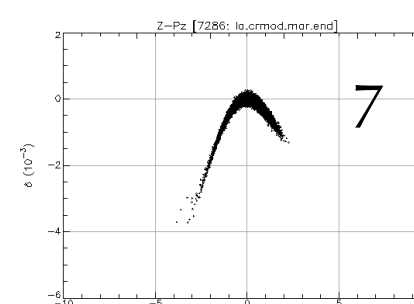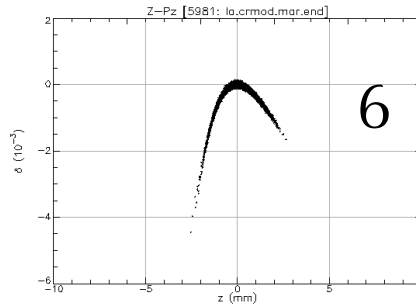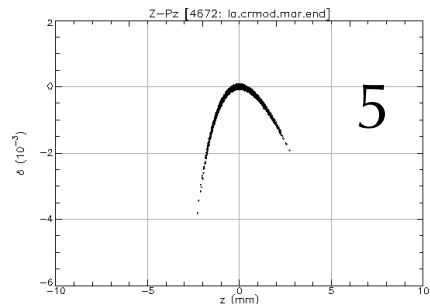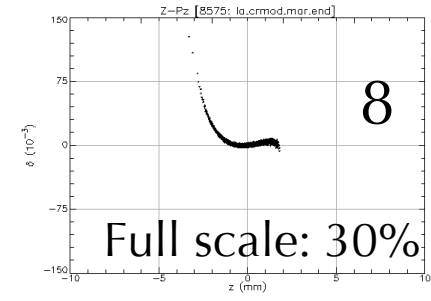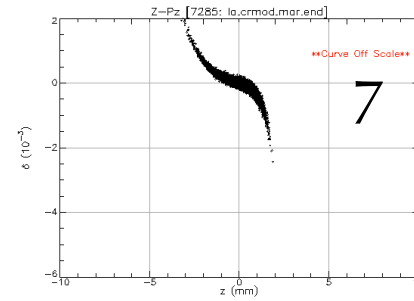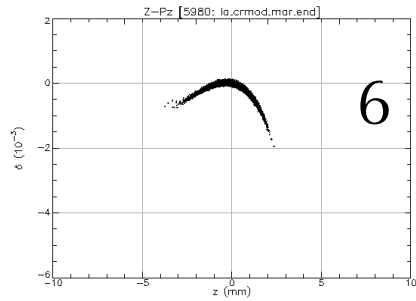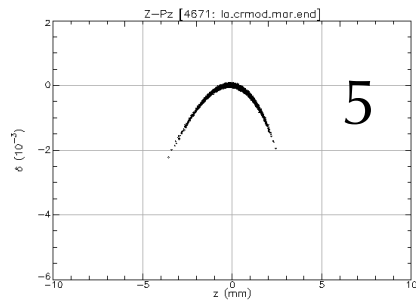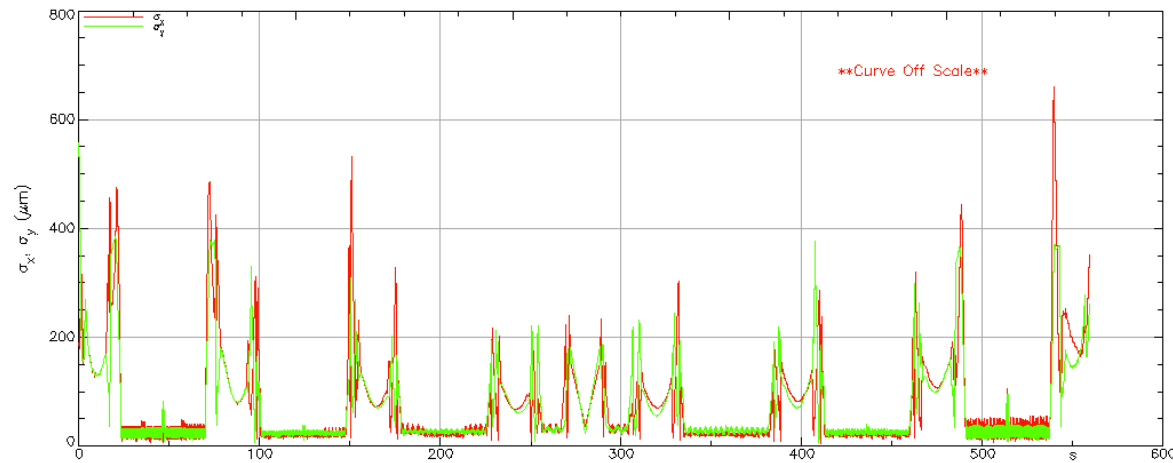
Simulation Software

Bmad & Tao (Cornell)

Revision: 15.0
April 28, 2011

Revision: 10.21
August 27, 2010

The
Bmad
Reference Manual

David Sagan

The
Tao
Manual

By David Sagan
and
Jeffrey C. Smith
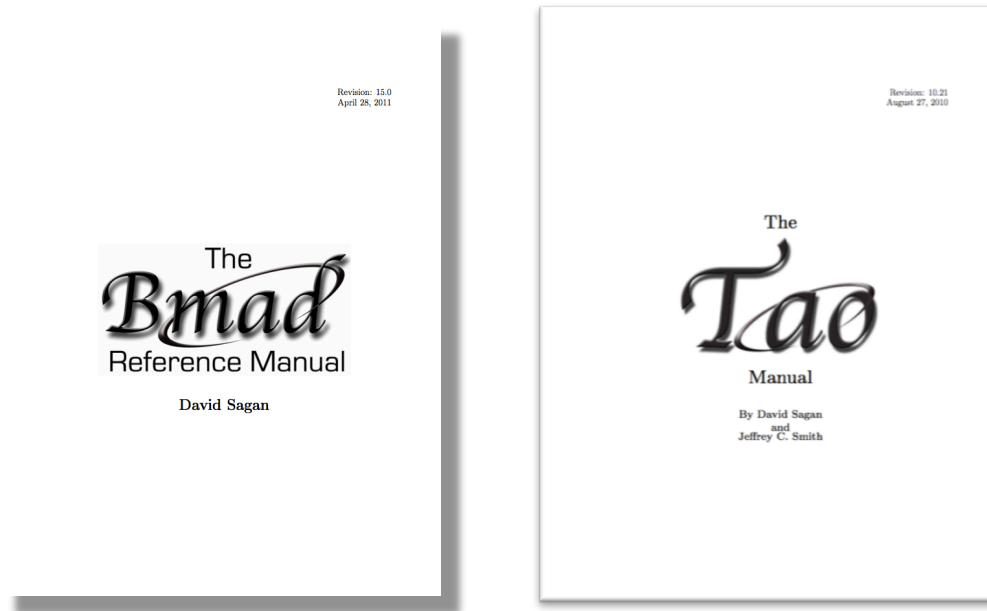
www.lns.cornell.edu/~dcs/bmad

Next steps

- Real fieldmaps (FFAG magnets, cavities, …)
- Wakefields (CSR, resistive wall, …)
- Injector + Linac space charge optimization
- Touschek scattering
- Dark current tracking & collimation
- BBU
- Ion trapping
- Orbit and optics correction
- Tolerance & stability analysis

FFAG orbit correction simulation

500 um rms x offset errors
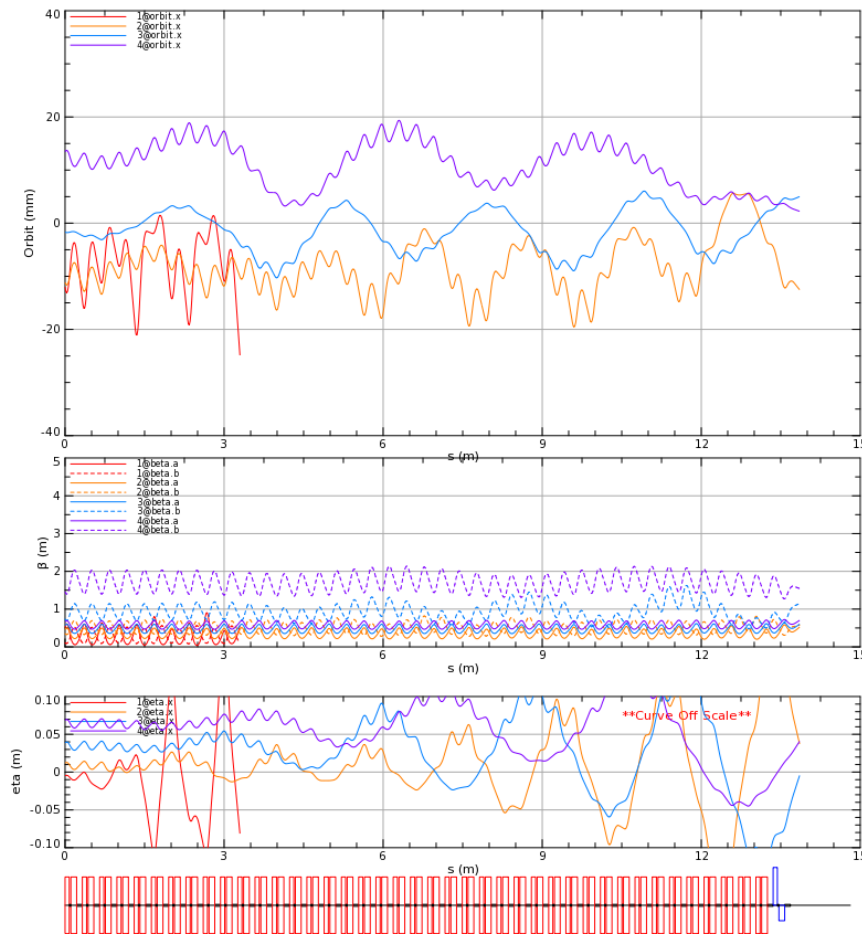
SVD correction given BPM readings for separate beams and correction coils on every other dipole
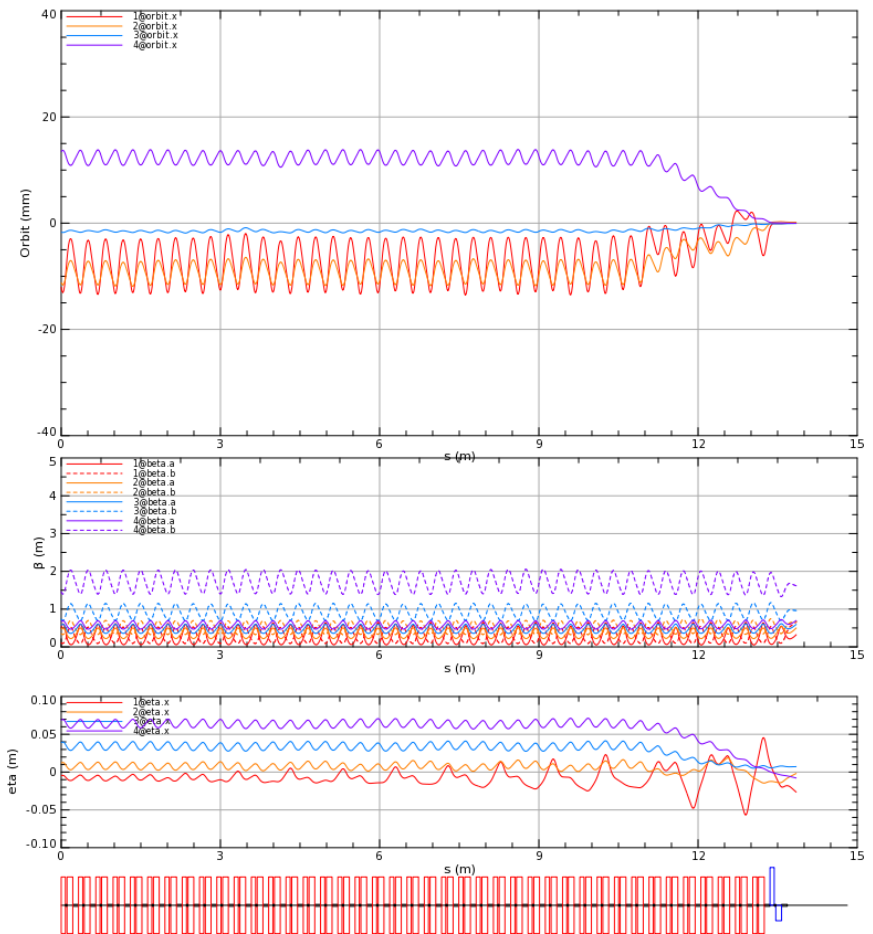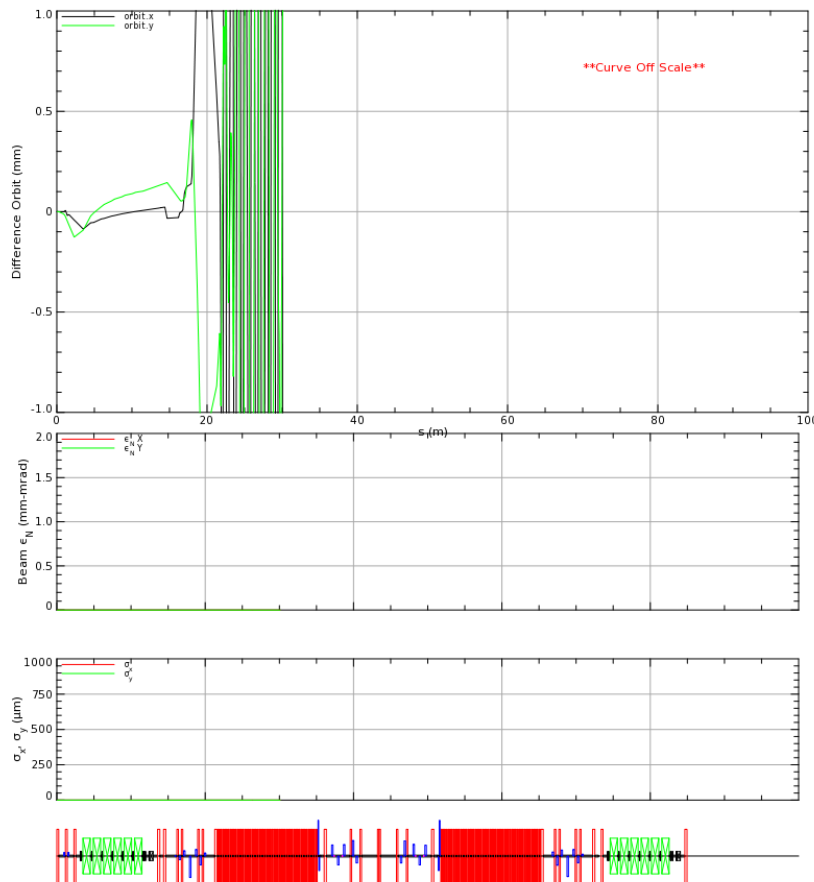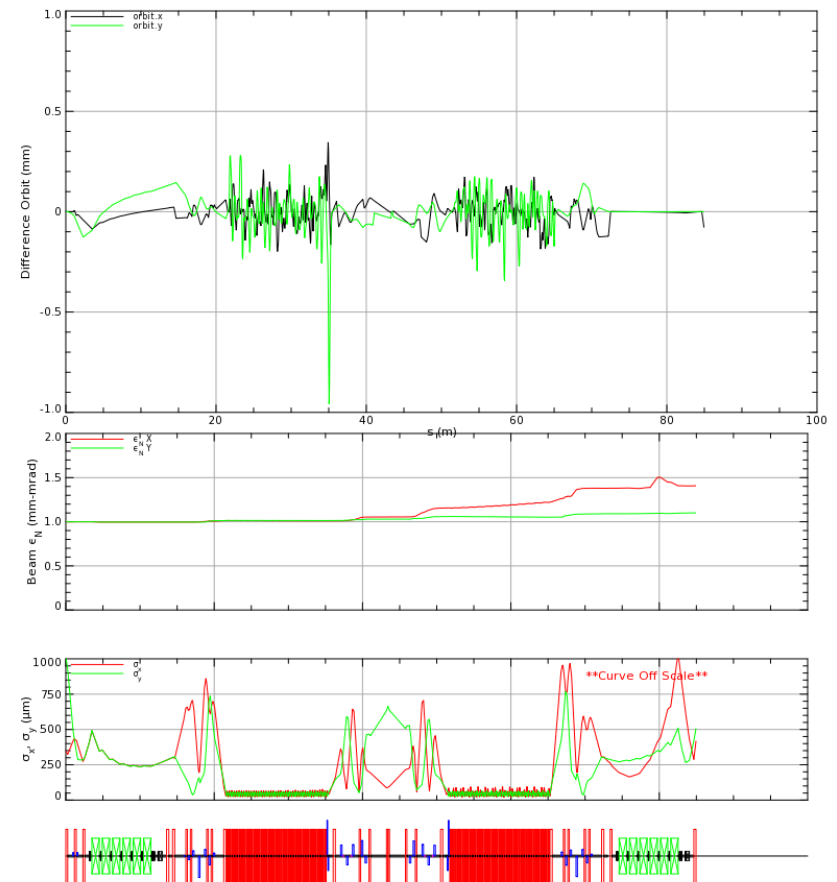

FFAG Arc

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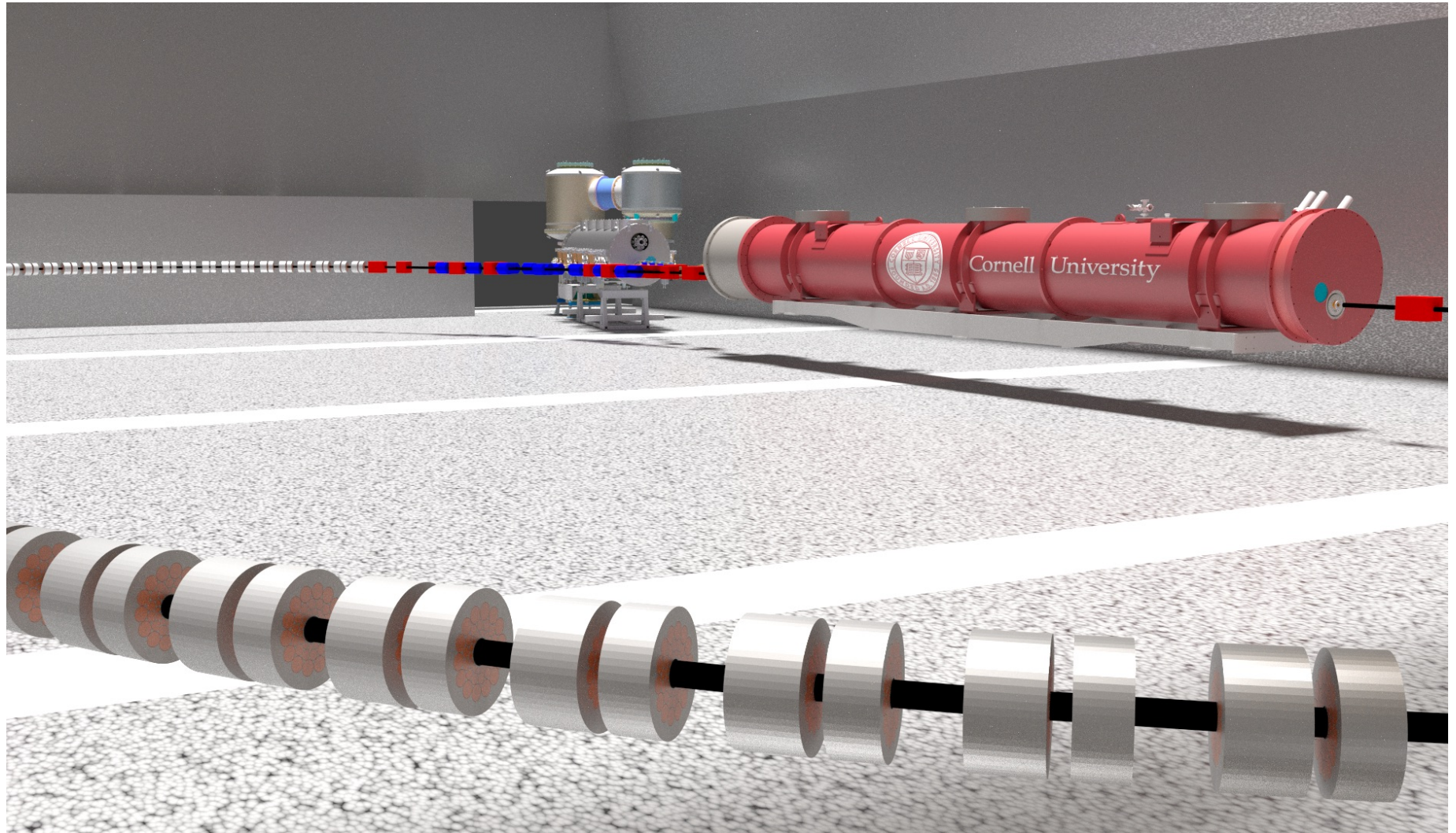# Example errors, correction, and bunch tracking

Variety of errors

SVD correction given BPM readings for separate beams and correction coils on every other FFAG dipole and all quadrupoles

1-pass ERL-FFAG (early design)

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End

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